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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/945,535	08/30/2001	Kie Y. Ahn	1303.026US1	2681
21186	7590	11/18/2003	EXAMINER	
SCHWEGMAN, LUNDBERG, WOESSNER & KLUTH, P.A. P.O. BOX 2938 MINNEAPOLIS, MN 55402			BLUM, DAVID S	
			ART UNIT	PAPER NUMBER
			2813	

DATE MAILED: 11/18/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

09/945,535

Applicant(s)

AHN ET AL.

Examiner

David S Blum

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 29 September 2003.
- 2a) ☒ This action is **FINAL**.                      2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1,2,4-10,12-15,17-23,25-31,33-37,51,52 and 54-56 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1,2,4-10,12-15,17-23,25-31,33-37,51,52 and 54-56 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. §§ 119 and 120**

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)                      4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)                      5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_                      6) ☐ Other: \_\_\_\_\_

This action is in response to Amendment E, paper #13 filed 09/29/03.

## DETAILED ACTION

### ***Claim Rejections - 35 USC § 103***

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1-2, 4, 14-15, 17, 51-52, and 54-56 rejected under 35 U.S.C. 103(a) as being unpatentable over Maiti (US006020024A) in view of Park (US 5,795,808), or Takeoka (US 4,647,947) or Thomas (US 4,920,071) and Ma (US006207589B1).

Maiti teaches all of the positive steps of claims 1-2, 4, 14-15, 17, 51-52, and 54-56 except for depositing an amorphous metal layer by electron beam evaporation at a range of 5.16 eV to 7.8 eV and it's purity level. Maiti teaches a zirconium (group IVB) layer is deposited on a transistor body region by an evaporation technique and oxidized to form an oxide layer (column 3 lines 30-52) between first and second source/drain regions (figure 3). A gate (20) is coupled to the metal oxide layer. It is understood that Maiti teaches vapor deposition of a metal oxide or sputtering and oxidation of a metal

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layer and that the instant application teaches electron beam evaporation as an improvement to sputtering and oxidizing the metal.

Regarding the process steps recited in "product by process claims" 51-54, the process steps are given little weight in product or device claims and Maiti teaches the device of claims 51-54. In re Thorpe, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985).

Park deposits a zirconium film by electron beam deposition (column 4 lines 16-17) at 99.0 purity or higher (column 4 line 25). Takeoka deposits a zirconium film by electron beam deposition (column 7 lines 65-68). Thomas deposits a zirconium film by electron beam deposition (column 4 lines 55-65). All three of the above references, taken alone or collectively, teach that electron beam deposition is a well-known art recognized equivalent method to sputtering.

Regarding the limitation of forming the layer with a conduction band offset in a range of 5.16-7.8 eV, as the process steps are identical and there is no teaching as to modifying the process to achieve the specified range, it is considered to be a range of common use, and one skilled in the requisite art would know how to optimize the process to achieve the range.

These ranges are considered to involve routine optimization while it has been held to be within the level of ordinary skill in the art. As noted in In re Aller (105 USPQ233), the

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selection of reaction parameters such as temperature and concentration would have been obvious:

"Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art. Such ranges are termed "critical ranges and the applicant has the burden of proving such criticality.... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."

In re Aller 105 USPQ233, 255 (CCPA 1955). See also In re Waite 77 USPQ 586 (CCPA 1948); In re Scherl 70 USPQ 204 (CCPA 1946); In re Irmischer 66 USPQ 314 (CCPA 1945); In re Norman 66 USPQ 308 (CCPA 1945); In re Swenson 56 USPQ 372 (CCPA 1942); In re Sola 25 USPQ 433 (CCPA 1935); In re Dreyfus 24 USPQ 52 (CCPA 1934).

One skilled in the requisite art at the time of the invention would have used any ranges or exact figures suitable to the method in the process of depositing material regarding energy levels using prior knowledge, experimentation, and observation with the apparatus used in order to optimize the process and produce the structure desired to the parameters desired.

Regarding the limitation that the metal layer be substantially amorphous, Maiti is silent as to whether the metal layer has crystal structure or is amorphous prior to oxidation. Park, Thomas, and Takeoka are also silent on this. Park only mentions that the metal chosen to form the layer may be from group IV metal elements with a hexagonal crystal structure (column 4 lines 19-23). This refers to the metal group, but not the metal layer formed. Ma, forms a gate oxide ((column 1 lines 13-15) by depositing a metal layer by an evaporation deposition method (column 2 lines 54-55 and 65-67) and then oxidizing

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the metal layer to form the metal oxide (column 3 lines 1-4). Ma teaches the layer remains amorphous (column 3 lines 54-55), thus the layer as formed is amorphous. Ma teaches that the reduces crystallinity (amorphous state) reduces electrical leakage (column 1 lines 53-58).

It would be obvious to one skilled in the requisite art at the time of the invention to modify Maiti by substituting electron beam evaporation as it is a well-known art recognized equivalent to sputtering and to form the layer in an amorphous state to reduce electrical leakage (as taught by Ma column 1 lines 53-58).

3. Claims 22-23, 25, 30-31, and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maiti (US006020024A) in view of admitted prior art (pages 1-4) and Park (US 5,795,808), or Takeoka (US 4,647,947) or Thomas (US 4,920,071) and Ma (US006207589B1).

Maiti teaches all of the positive steps of claims 22-23, 25, 30-31 and 33, except for the application of wordlines, sourcelines, bitlines and system busses and depositing the metal by electron beam evaporation and the purity level. Maiti teaches a zirconium (group IVB) layer is deposited on a transistor body region by an evaporation technique and oxidized to form an oxide layer (column 3 lines 30-52) between first and second source/drain regions (figure 3). A gate (20) is coupled to the metal oxide layer. It is understood that Maiti teaches vapor deposition of a metal oxide or sputtering and

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oxidation of a metal layer and that the instant application teaches electron beam evaporation as an improvement to sputtering and oxidizing the metal.

Maiti teaches that the device formed is a metal oxide field effect transistor with a high k metal gate for IC's. The admitted prior art (pages 1-4) teaches that these devices are commonly used in IC's particularly processor chips, mobile telephones, and memory devices. These devices commonly use wordlines, sourcelines, bitlines and system busses.

Park deposits a zirconium film by electron beam deposition (column 4 lines 16-17) at 99.0 purity or higher (column 4 line 25). Takeoka deposits a zirconium film by electron beam deposition (column 7 lines 65-68). Thomas deposits a zirconium film by electron beam deposition (column 4 lines 55-65). All three of the above references, taken alone or collectively, teach that electron beam deposition is a well-known art recognized equivalent method to sputtering.

Regarding the limitation that the metal layer be substantially amorphous, Maiti is silent as to whether the metal layer has crystal structure or is amorphous prior to oxidation. Park, Thomas, and Takeoka are also silent on this. Park only mentions that the metal chosen to form the layer may be from group IV metal elements with a hexagonal crystal structure (column 4 lines 19-23). This refers to the metal group, but not the metal layer formed. Ma, forms a gate oxide ((column 1 lines 13-15) by depositing a metal layer by

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an evaporation deposition method (column 2 lines 54-55 and 65-67) and then oxidizing the metal layer to form the metal oxide (column 3 lines 1-4). Ma teaches the layer remains amorphous (column 3 lines 54-55), thus the layer as formed is amorphous. Ma teaches that the reduces crystallinity (amorphous state) reduces electrical leakage (column 1 lines 53-58).

One skilled in the requisite art at the time of the invention would modify Maiti by completing the device and circuit to form IC's, particularly processor chips, mobile telephones, and memory (arrays) devices (which include wordlines, sourcelines, bitlines and system busses) as taught by the admitted prior art to be conventional practice and to include substituting electron beam evaporation as it is a well known art recognized equivalent to sputtering and to form the layer in an amorphous state to reduce electrical leakage (as taught by Ma column 1 lines 53-58).

4. Claims 5-7, 18-20, 26-28, and 34-36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maiti (US006020024A) in view of the admitted prior art and Park (US 5,795,808), or Takeoka (US 4,647,947) or Thomas (US 4,920,071) and Ma (US006207589B1) as applied to claims 1, 14, 30, above, and further in view of Yano (US005810923A).

Maiti, Park, or Takeoka, or Thomas and Ma, and the admitted prior art teach all of the positive steps of claims 5-7, 18-20, 26-28, and 34-36 except for the temperature of the



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substrate, oxidizing in atomic oxygen, and oxidizing temperatures. Maiti is silent as to the substrate temperature and oxidizing temperature. Yano teaches electron beam evaporation of zirconium oxide at substrate temperatures of 300-700 degrees Celsius (column 10 line 5). Although Yano is depositing zirconium oxide, not zirconium as Maiti, Yano suggests reasonable temperatures for the deposition and oxidation of the metal. These ranges are considered to involve routine optimization as recited above.

Yano deposits the metal layer with atomic oxygen (electron beam) suggesting that Maiti could anneal in atomic oxygen rather than molecular oxygen. "the oxidizing gas used herein may be oxygen, ozone, atomic oxygen and NO<sub>2</sub>." (column 21 lined 35-36), thus teaching an art recognized equivalence for oxygen and atomic oxygen in oxidizing zirconium.

One skilled in the requisite art at the time of the invention would have modified Maiti, Park, or Takeoka, or Thomas, and the admitted prior art by substituting atomic oxygen for molecular oxygen as suggested by Yano and used any ranges or exact figures suitable to the method in the process of deposition regarding temperature using prior knowledge, experimentation, and observation with the apparatus used in order to optimize the process and produce the metal oxide layer structure desired to the parameters desired.

5. Claims 8-10, 12-13, and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maiti (US006020024A) in view Park (US 5,795,808), or Takeoka (US

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4,647,947) or Thomas (US 4,920,071) and Ma (US006207589B1) and in further view of Moise (US006211035B1) and Yano (US005810923A)..

Maiti, Park, or Takeoka, or Thomas and Ma, teaches all of the positive steps of claims 8-10, 12-13, and 21 as recited above, except for annealing the metal layer (type IVB, zirconium) in a plasma of krypton and oxygen. Moise teaches layers of ZrO<sub>2</sub> can be formed either as an oxide or a metal layer that is oxidized (column 10 lines 53-57). Moise also teaches a method for oxidizing within the used equipment by using an oxygen-containing plasma along with an optional inert gas (column 8 lines 11-13), defining inert gas as helium, neon, argon, krypton, or xenon (column 12 lines 23-24).

Park deposits a zirconium film by electron beam deposition (column 4 lines 16-17) at 99.0 purity or higher (column 4 line 25). Takeoka deposits a zirconium film by electron beam deposition (column 7 lines 65-68). Thomas deposits a zirconium film by electron beam deposition (column 4 lines 55-65). All three of the above references, taken alone or collectively, teach that electron beam deposition is a well-known art recognized equivalent method to sputtering.

Although Yano is depositing zirconium oxide, not zirconium as Maiti, Yano suggests reasonable temperatures for the deposition and oxidation of the metal. These ranges are considered to involve routine optimization as recited above.

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One skilled in the requisite art at the time of the invention would modify Maiti by substituting electron beam evaporation as it is a well known art recognized equivalent to sputtering and including krypton as the inert gas during oxidation as known to be conventional practice in the art.

6. Claims 29, and 37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maiti (US006020024A) in view of admitted prior art and Park (US 5,795,808), or Takeoka (US 4,647,947) or Thomas (US 4,920,071) and Ma (US006207589B1) and in further view of Moise (US006211035B1).

Maiti, Park, or Takeoka, or Thomas and Ma, and the admitted prior art teach all of the positive steps of claims 29 and 37 as recited above except for annealing the metal layer (type IVB, zirconium) in a plasma of krypton and oxygen. Moise teaches layers of  $ZrO_2$  can be formed either as an oxide or a metal layer that is oxidized (column 10 lines 53-57). Moise also teaches a method for oxidizing within the used equipment by using an oxygen-containing plasma along with an optional inert gas (column 8 lines 11-13), defining inert gas as helium, neon, argon, krypton, or xenon (column 12 lines 23-24). One skilled in the requisite art at the time of the invention would modify Maiti and the admitted prior art by including krypton as the inert gas during oxidation as known to be conventional practice in the art.

***Response to Arguments***

***Response to Arguments***

7. Applicant's arguments with respect to claims 1-2, 4-10, 12-15, 17-23, 25-31, 33-37, 51-52, and 54-56 have been considered but are moot in view of the new ground(s) of rejection.

***Conclusion***

8. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.


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9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to David S. Blum whose telephone number is (703)-306-9168 and e-mail address is David.blum@USPTO.gov .

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead Jr., can be reached at (703)-308-4940. Our facsimile number all patent correspondence to be entered into an application is (703) 872-9306. The facsimile number for customer service is (703)-872-9317. Our receptionist's number is (703)-308-0956.

David S. Blum

November 13, 2003

  
CARL WHITEHEAD, JR.  
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